Space Weather Technical Forecast

Issued on Thursday 5 December 2024 at 12:07 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares Likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Moderate at GOES16, with occasional low-level M-class flares observed. An M1.3-M1.4 doublet from AR3916 and AR3917 was seen around 04/2100UTC, trumped late in the period by an M2.5 from a region on the southwest limb, with this event also tied to a Type II radio burst. Imagery to assess any CME is pending, although the emission region is around 90 West.

There are currently up to eight sunspot regions, with AR3906 no longer discernible on the western limb, and with two unnumbered small unipolar regions near centre-disc. The main trends observed in the period have included the migration of a southern peripheral spot westwards relative to its main spot in AR3910, although this group appears unipolar in available NSO GONG imagery. Also of note were a proliferating and spreading tendency in newly-numbered AR3917 in the far southeast, with small penumbrae developing on some of the spots. Finally, AR3916 retained its compressed appearance, with a large asymmetric leader and a profusion of minor intermediate spots. These trends are all lower confidence than is typical given lower resolution of NSO intensitygram and magnetogram imagery versus SOHO HMI.

The current disc is currently harbouring a large number of filaments, including a very large series of filaments circumscribing the southeastern part of the Sun containing AR3916 and AR3917. The bulk of these filaments are remote from more obviously destabilising sunspot regions, however they will be increasingly relevant as they rotate westwards should they depart the disc. Filaments in the northwest near AR3910 were more remote from the solar 'surface' (i.e. correlate poorly with magnetogram boundaries), although again there are no immediate signs of lifting off here.

A faint CME was seen on Lasco C2 during the UTC evening of 04 December (between 1 o'clock and 4 o'clock plane-of-sky), however this could not be correlated with any obvious front-sided activity. No Coronal Mass Ejections (CMEs) are thought to have Earth-directed components at the time of writing.

Solar Wind / Geomagnetic Activity: Solar winds measured by DSCOVR and ACE showed a gradual relaxation towards a slow regime in the period. Solar wind speeds fell from Elevated highs are 525km/s to reach 425 by the period's end. The solar wind density was level within single-figures ppcc (disregarding measurement differences between the L1 satellites). The IMF showed a

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level tendency with an 8nT peak and a north-south variation between +/-6nT. The phi angle was negative (towards the Sun) throughout.

The net result of the above solar wind measures was for provisionally Quiet geomagnetic activity throughout the past 24 hours.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at Background.

High energy electron flux (greater than 2MeV) observed by GOES16 was at Normal Background. The associated 24-hour fluence was below Active. The 05/0001UTC observation was 1.08e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: M-class flares are considered Likely throughout.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs feature in the forecast. There are no coronal holes fast wind connections expected through the period, with slightly elevated winds easing to be mainly background. Geomagnetic activity is forecast to be Quiet, with isolated Unsettled intervals.

Energetic Particles / Solar Radiation: High energy protons are expected to persist at Background. There is a now slightly increased risk of S1 in the tail end of the current UTC working week given the 05/1040UTC M2.5 in a prone location. This risk should relax back to its previous residual into the UTC weekend.

High energy electron flux is expected to persist mainly at Normal Background, with the associated 24 hour fluence remaining below the Active threshold.

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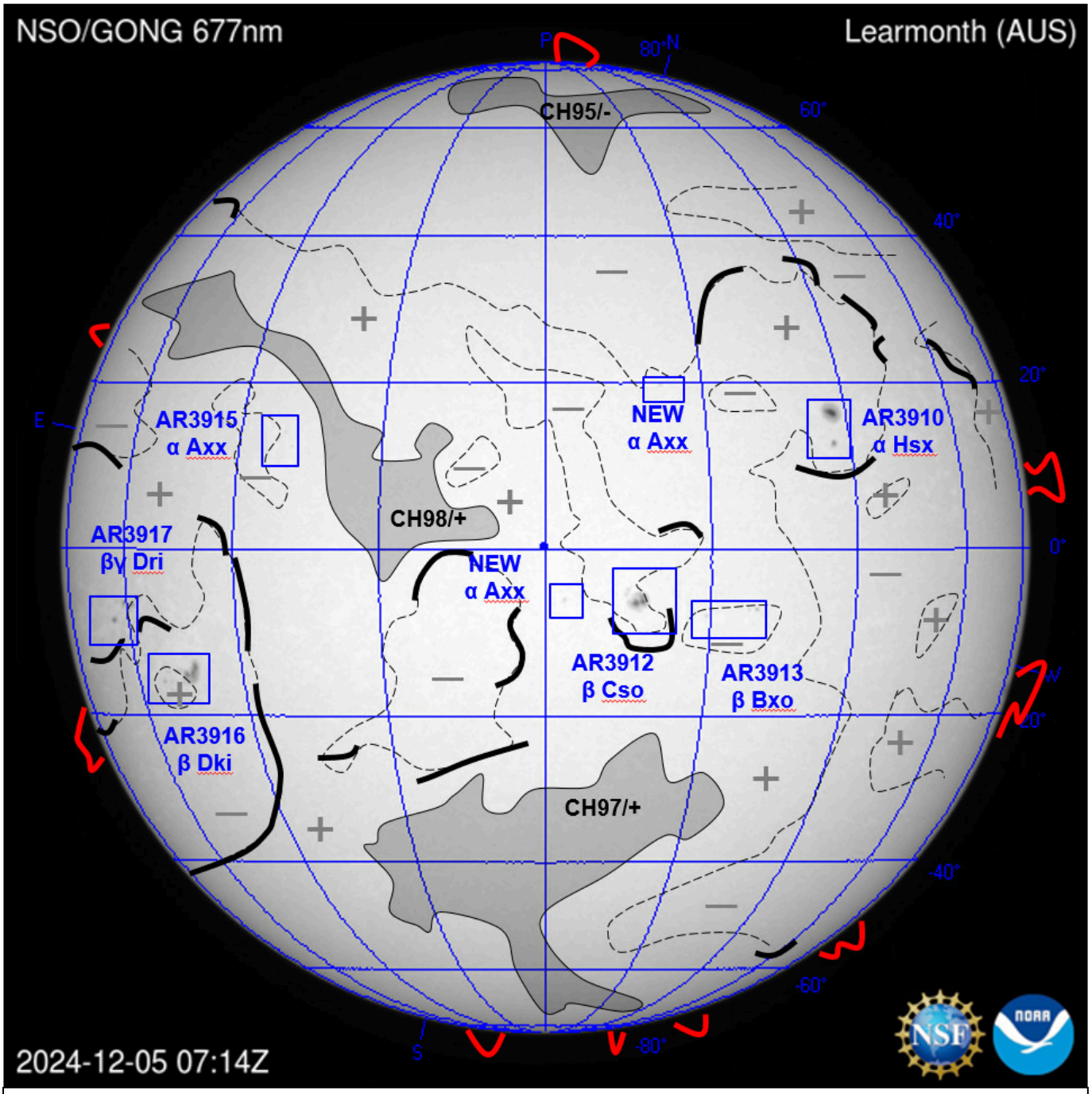
Figure 1: Solar Synoptic Map, valid 05/0715UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

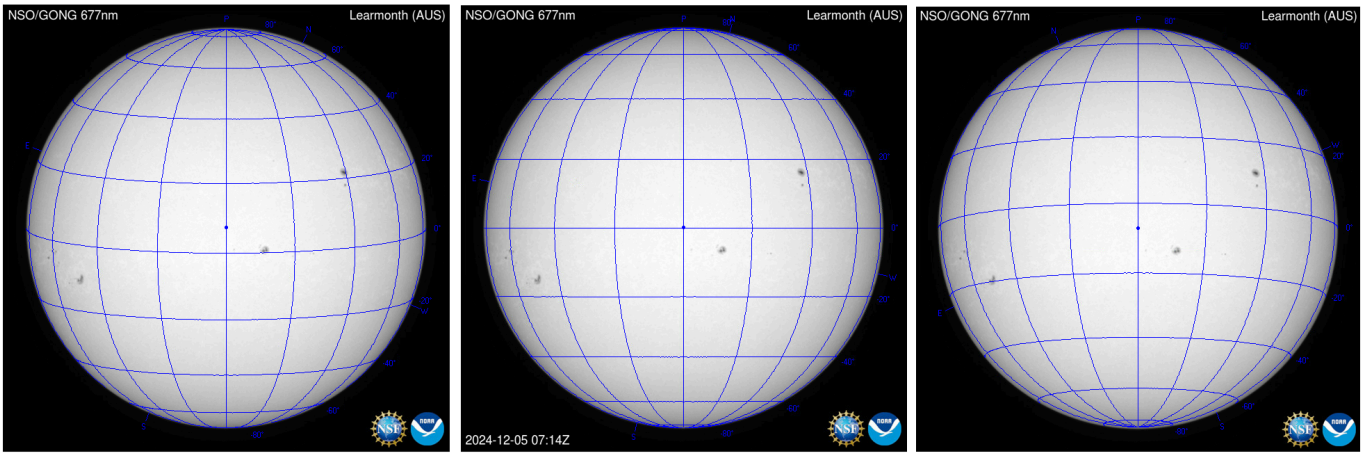
No CMEs and no coronal hole fast winds feature in the four-day forecast, although the solar disc is congested with filaments. This render the continuation of a clean slate in terms of CMEs lower than average confidence.

Earth crosses the plane of the Sun's rotation axis southwards on Saturday 07 December, and it is around this time that coronal holes of any polarity are at the semi-annual minimum in terms of geoeffective potential. Current solar wind speeds in MOSWOC Enlil are underdone compared with reality, but are expected to be too fast through the current UTC day due to Enlil's idea of connecting to a high speed stream from CH97+. CH97+ looks too far south in reality to cause any enhancement - CH97+ is a persistent feature and had no perceptible influence on the observed solar wind.

All considered, geomagnetic activity is forecast to be Quiet with isolated Unsettled intervals.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Visualisation of 20-degree latitude and longitude division grid aligned to the Sun's rotation axis, with the sub-Earth point the central blue spot. Shown are 07 September, December and March (the underlying intensitygram is current in all cases).



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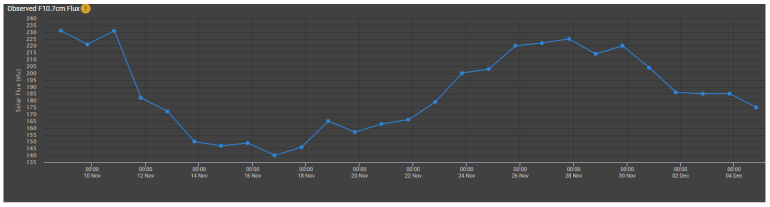
Radio Blackouts - X-Ray Flares

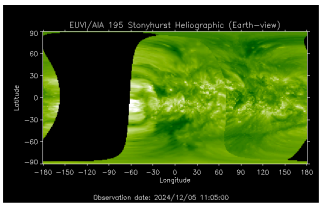
The balance of sunspot regions on the front side is likely to be relatively stable through the period, and any rise or fall in daily probabilities will likely be tied to developments on the current disc, rather than arriving or departing regions. At present, most activity and development appears to be focussed on the southeastern quadrant, making any activity here of increasing relevance for the geomagnetic forecast given CME potential. Assessing magnetic complexity is complicated by the relatively lower resolution of NSO GONG magnetogram and intensitygram imagery versus SOHO HMI, however AR3916 appears to carry the most complexity in its Dki/Beta Zurich classification, with AR3917 a smaller but more developmental Dri/Beta-Gamma.

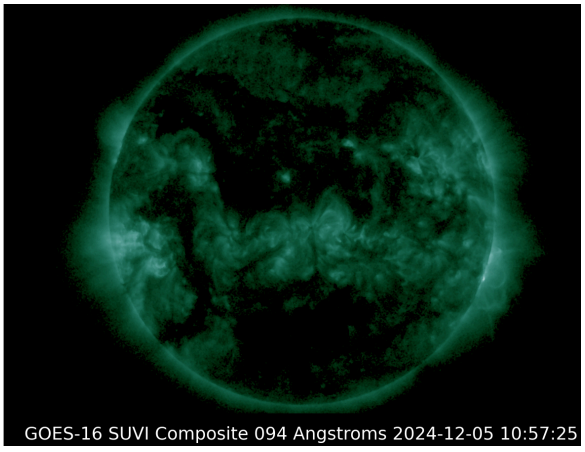
The chances of X-ray flares are held constant throughout and above raw values given the cadence of recent low-level M-class flares from numerous sources. M-class flares are rated at Likely each day, with a Slight Chance of X-class.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	60	60	60	60
Very Active	R3-R5 (X Class)	No	5	5	5	5

Figure 3: Relevant measures of solar activity - clockwise from top left: 27-day Penticton 10.7cm flux, showing a levelling trend at a relatively low level compared to last pass; current GOES16 094 Angstrom image showing mainly limb-ward distribution of areas of bright flux; and a compiosite image in 195 Angstroms of the Earth-facing disc and partial far-side.







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Solar Radiation Storms (High Energy Protons)

GOES18 proton flux is currently at Background. There is a now slightly increased risk of S1 in the tail end of the current UTC working week given the 05/1040UTC M2.5 in a prone location. This risk should relax back to its previous residual into the UTC weekend.

While there are a couple of moderately sized regions on the better-connecting western disc and Ex-AR3905 and Ex-AR3906 narrowly over the limb, there has been no recent history of even minor proton enhancement seen in the near-Earth environment. There is a daily Slight Chance of high energy proton enhancement through this period - this now includes the risk of S1 already mentioned from the M2.5 flare, overlaying the previous level trend of far-sided regions' contributions decreasing in tandem with the slight overall rise from the westward progression of the front-sided groups.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy Electron flux observed by GOES16 is at Nomral Background. This is expected to persist, with no significant coronal hole or CME enhancements currently anticipated during the forecast period.

The associated 24-hour fluence is expected to persist below Active levels, with MOSWOC REFM currently considered to be providing good guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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